LIFE CYCLE ASSESSMENT OF THE SYSTEM OF INTEGRATED MANAGEMENT OF MUNICIPAL WASTE FROM ORADEA

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Abstract

Life-cycle analysis (LCA) is widely used both in Europe and overseas, in the studies related to improve waste management, because it is the foundation of decision-making processes based on evidence. However, there are few studies which use the methodology L.C.A. in Romania and in Oradea there is a real need of improvement in this sector. Household waste in Oradea involves selective collection of waste at source on the four fractions. Having regard to Council that a higher percentage of the population lives at the block, and the waste collection is organized for many families, it is difficult to establish the selection of waste to be carried out on several fractions of waste. Therefore, the purpose of the study is: (1) to identify if the selective collection of waste at source on four fraction is more effective in report of the protection of the environment than waste collection at source only on two fractions; (2) identify the most appropriate solutions for the collection and transport of waste generated in Oradea, taking into account the impact of the proposed scenarios on the environment.

Key words: life cycle assessment, municipal solid waste management, source separated collection, integrated waste management

INTRODUCTION

Life Cycle Assessment is a structured, comprehensive and standardized at international level. Carry out all relevant emission quantification, the resources consumed and the impacts, the environmental and health matters of exhaustion of resources which are associated with any goods or services („Products"). (McDougall, F.R., et al, 2001) Life cycle assessment takes account of all the life cycle of a product: extraction of resources, from which it is created, the production, use and recycling to disposal of waste remaining.

To obtain patterns of production and consumption more sustainable development, we must take into account the environmental implications of the entire supply chain with products, both goods and services, as well as their use and waste management, i.e. the entire life cycle of the „Cradle to grave". (ILCD Handbook: General guide for Life Cycle Assessment - Detailed guidance, 2010)

As defined, L.C.A. relates only to the environmental impact of the product and does not treat financial factors, political, social, etc. (for example, the impact on the costs).

The life cycle of a product, the product starts at the time of design and continue through the acquisition and use of raw materials, manufacture or processing associated with the waste stream, storage, distribution, use and disposal or recycling of the withdrawal. (8)

In the life cycle to be included and the phases of transport or caused by the existence of the product. The first forms of L.C.A., have been used in the United States in the 1960's, for defining the Corporate Environmental Strategy and subsequently, in the 1970's, were used even by government agencies, as auxiliary for the development of public policies.

The first international body which acted for the development of the LCA has been SETAC (*Society of Environmental Toxicology and Chemistry*) in the USA. SETAC has elaborated a „code of practice" for LCA, who developed the first frame technically accepted international studies LCA.

MATERIAL AND METHOD

In accordance with the definition of data, L.C.A. being a technique of environment management for the evaluation of the environmental aspects of the product-systems and the associated potential impacts, it is guided and transposed into practice, by performing the four phases:

- Defining the purpose and scope;
- The analysis of the inventory for the relevant elements of entry and exit of a system-product;
- Evaluation of potential impacts on the environment;
- Interpretation of the results of the analysis phase of the inventory and evaluation of the impacts.

Life Cycle Assessment may contribute to the merits of decisions in the industry, governmental and non-governmental organizations, to develop strategic plans, the design of the products or processes, and for the evaluation of alternative methods of manufacture, from the point of view of environmental requirements which must be met. (Koroneos, C.J.; Nanaki, E.A. 2012)

Dividing in some cases may be sufficient for analysis required by the study objectives:

- *The Cradle - to - Gate* is an analysis of the life cycle of the product, from the manufacturing („*cradle"*) up to the gate („*gate"*) factory, i.e. before being transported to the consumer;
- *Cradle to cradle* is a type of Life Cycle Assessment in which the final phase, post-use is a process of recycling; recycling of their original new products identical to those recycled, to different products.
- *The gate to gate* - - is a partially L.C.A. which takes into account only a single process that adds value to the entire chain of production.

On the occasion of the study L.C.A. may be taken into account the contribution to the following categories of environmental impact:

- The contribution to the greenhouse effect;
- The impact on the ozone layer stratospheric;
- The contribution of the acidic rains (via emissions of SO_2);
- Water pollution of the sails of groundwater, waste water treatment systems, cooling water;
- The use of energy (electricity, gas, oil, etc.);
- Air pollution, toxic gases;
- The erosion, soil degradation of forests;
- Noise, vibration;
- Dust and particles;
- Explosions, discharges, solid wastes, hazardous wastes.

A system of integrated management of solid waste is a system optimized for waste management, which takes account of both the environmental aspects, as well as the economic. (Huppes G., Curran, M.A., 2004)

One of the main methodologies capable to reduce the environmental impacts by I.S.W.M. is to assess the life cycle, which is known as a technique efficiency to identify, quantify and assess the energy, waste and materials used for the environment, for a specific subject (regardless of whether it is product, process or activity). (Eco-indicatorul 99 Manual for designers)

Therefore, in the municipality of Oradea was implemented such a system which is focused on three scenarios about which we will discuss in this work.

The analysis of the categories of environmental impact in Romania is complicated by the lack of necessary scientific methodology for the evaluation of the environmental impact of the processes. The models for the categories of impact are still in the process of development. However there is at present some programs (software) to assist in the evaluation of a

product's life cycle: SimaPro, 2016, EASETECH ReCiPe and Eco-99 which has been used for the attainment of this study.

RESULTS AND DISCUSSION

Life Cycle Assessment of waste is carried out to discover their effects on the environment. Separate collection directly from the source of the municipal solid waste began in Oradea in 2013. Three management systems are compared and the functional unit is defined as the annual generation of waste in the city of Oradea.

Waste collection will be made in the system of 4 containers: blue for paper and cardboard, glass green, yellow for plastics and other recyclable waste and black for waste. After the collection of the waste, the residual fraction will be transferred to the transfer stations for the compaction and then for final storage (or TMB), and recyclable fraction will be transported to the sorting stations and waste will be recovered. The ecologic landfill from Oradea will carry all waste from Bihor County: 125000 t/year municipal solid waste and 5800 t/year sludge from sewage plants so a total of 130800 t/year or 358,3 t/day. (7)

In this study, municipal waste from Oradea (which amounted to 102,7 tons/day) shall be assessed according to the three scenarios suggested above. The method of life cycle assessment has been applied for each scenario, and finally we selected the most efficient scenario for the management of solid waste from Oradea.

Scenario 1 is the sort on four fractions;

Scenario 2 is represented by treatment mechanical-organic waste after sorting;

Scenario 3 is storage as less waste remaining after the previous scenarios.

The purpose of this evaluation, for municipal waste in Oradea city, is to investigate possible effects on the environment of the different scenarios for the management of solid waste. This results in choosing the best system of disposal. The level of awareness of the decision-makers will be based on the results of this research and will lead to an eventual reduction of future adverse effects on the environment.

In accordance with the scenario 1, wastes that will result from the sorting, from these stations are:

- 20 01 01 paper and cardboard
- 19 10 01 ferrous metal
- 19 10 02 non-ferrous metals

- 17 02 03 plastics and rubber
- 20 01 02 glass, according to the list of waste approved by the European Union.

Table 1

The main sorting stations created by the project ISWM in Bihor County

Location	Parameter	Capacity (t/year)
Oradea (Base Station Sort existence)	Recyclable materials	37500
		The paper/board: 8214 Glass: 114 Metal 2592 Plastic: 7867
	Waste resulting from the process	18713
Alesd (Base Station Sort existence)	Recyclable materials	4000
		The paper/board: 824 Glass: 140 Metal: 310 Plastic: 726
	Wastes that will be stored	2000
Salonta (New station)	Recyclable materials	4500
		The paper/board: 1137 Glass: 117 Metal: 318 Plastic: 828
	Wastes that will be stored	2100
Beius (New station)	Recyclable materials	7000
		The paper/board: 1598 Glass: 201 Metal: 500 Plastic: 1201
	Wastes that will be stored	3500
Marghita (New station)	Recyclable materials	4500
		The paper/board: 1126 Glass: 150 Metal: 318 Plastic: 806
	Wastes that will be stored	2100
The Valley of Mihai (Station existence optimized by project)	Recyclable materials	4500
		Covers weathertight paper/board: Glass: 260 Metal: 320 Plastic: 866
	Wastes that will be stored	2088

The Sorting stations shall have the following functions:

- The processing of waste generated selectively collected;
- Selecting inappropriate waste from coarse type before processing Sort by:
- Sorting the recyclable waste generated on the categories and qualities of raw materials;
- The collection of the refusal of the sorting facility;
- The processing for the transport of selected fractions and refusals to;
- Temporary storage of the fractions selected and refusals to give recognition.

In accordance with the scenario 2, wastes which may be treated mechanical-biological in new station built by the European project integrated management of wastes which is financed by the European Union are:

- 20 02 waste from gardens and parks (including waste from cemeteries)
- 20 03 01 mixed municipal waste
- 20 03 02 waste from markets
- 20 03 03 street waste
- 20 01 08 biodegradable waste from kitchens and canteens
- 20 01 07 wood
- 20 03 municipal waste without further specification

Biological treatment mechanical-consists of 4 steps:

- The pre-treatment mechanical - includes an operational line with the following equipment: the chopper, permanent magnet, rotary screen;
- Biological treatment - residual fraction shall enter in the heaps covered to which they apply forced ventilation. The material remains in a pile for 4 weeks and 25 % by weight entered is lost in the form of water vapor, CO_2, volatile compounds and leachate;
- The refining - estimated quantity of compost like product to be produced is 22194 tons per year (approx. 37 % of the quantity shall enter), and residue around 25582 tons per year (42,6 % of the quantity which will be discharged into the warehouse. The losses in the biological treatment are approximately 10134 tons per year (17 % of the quantity entering). Ferrous metals represent 2090 t/year (3.5 % of the quantity shall enter);
- The Maturing - treated material biological, after refining is sent to the area of aging. It will remain there for 15 days, in a pile, to mature and get the desired final characteristics. The charger must return the

material to accelerate the process of Maturation. The quantity produced per day it arrives in the area of aging is 162 m^3.

After these steps wastes are classified as follows:

- 19 05 01 non-composted fraction of municipal waste and which may be treated
- 19 05 03 composting without specifying the origin
- 19 05 99 other wastes not specified
- 19 10 01 waste of iron and steel
- 19 10 02 non-ferrous metal waste
- 19 10 04 fraction of the span slightly and dust, other than those specified at 19 10 03. (Do not contain dangerous substances),

These types of waste are those which will be stored in the Ecological Landfill, Episcopia, Bihor, in accordance with the scenario 3.

Must specify that, through this integrated management wastes system we promote individuals composting both in urban areas and in rural areas. It is estimated that approximately 4600 t/year of biodegradable waste will be composted individually. For this purpose the population will be informed through awareness campaigns on the way in which will be used comportments delivered with a capacity of 300 liters and for what types of waste will apply composting: Fruit, vegetables, flowers, wet paper, coffee and other drinks.

CONCLUSIONS

There is a big uncertainty in all major processes for the treatment of solid waste. The lack of quality data in respect of the waste management practices is a problem recognized by any person who makes a study on LCA. (McDougall, et al 2001).

Disposal of waste, the option of management of solid waste, used on a large scale in the world, has a lot of uncertainties related to the length of time of its impacts on the environment. Obersteiner et al (2007) reports that data relating to the processes with direct measurements (such as collection, recycling and treatment) are more reliable than the data from the deposits of waste which are partly modified and in some cases they are even estimated.

In report of the collection, sorting and storage of municipal solid waste, L.C.A. analyzed in this work has shown the following conclusions:

- The small volume containers have the most impact on the environment;

- HDPE containers have a greater impact in comparison with steel containers;
- The collection system - Multiple container- has the greatest impact on the environment while the collection system door-to-door has the greatest impact on public awareness;
- Selective collection system is the system that brings the best efficiency.

As regards the integrated management of wastes has been identified the following conclusions:

- Disposal of waste (even the few who still remain) is a serious option of management;
- Life Cycle Assessment of this system brings significant savings in energy recovery environment created by such wastes; The same is true for the recovery of materials, and particularly of metals;
- The sorting of waste categories involves both personnel employed and installations which will be folded up these wastes; But it will be recycled later (even with the addition of material) is an option of management very viable in this integrated management system;
- The treatment, in the new station built, and waste with high calorific value should be pursued since it will be able to use this energy in the future in other purposes;
- Finally, selecting the best scenario depends on the examined the impact on the environment.

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